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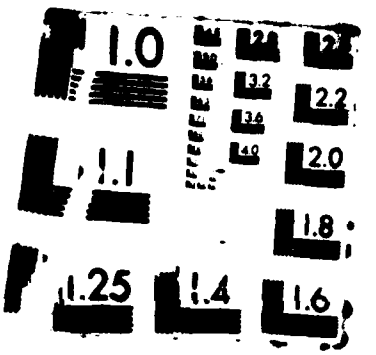
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# MORTON ARBORETUM BIOASSAYS

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# EARTHWORM BIOASSAY PROCEDURES TO EVALUATE THE EXTENT OF AERIALLY DISPERSED LEAD AND CADMIUM IN AN URBAN ARBORETUM

G.S. Wilhelm[1], J.W. Simmers[2], J.M. Marquenie[3] , and P.D. Kelsey[1]

## ABSTRACT

Aerially dispersed heavy metals from a high speed motorway have been shown to be entering an urban arboretum. Lead (Pb) and Cd were found as remote as 930 m from an east-west, multi-lane motorway. Both Pb and Cd were bioavailable to earthworms (*Eisenia foetida* ) and both metals were more concentrated in surface soils than at depths of 1 meter.

1 The Morton Arboretum. Lisle, Illinois 60532. U.S.A.
2. U.S. Army Waterways Experiment Statiion, Vicksburg, Mississippi, 39180 USA.
3. Division of Technology for Society, TNO. 1985. Den Helder, The Netherlands.

## METHODOLOGY

A transect was laid out northward and perpendicular to an east-west, multi-lane motorway which runs nearly the entire southern border (ca. 3.6 km) of the arboretum. Seven sampling stations were established at progressive intervals along the 930 m transect ~~(Table 12)~~. At all sampling stations, soil cores 15 cm deep and replicated four times were collected. The sod was removed from each sample except for one station 33 m away from the motorway. This was retained and tested along with some additional 1 m depth soil cores.

All samples were transported to the U.S. Army Engineer Waterways Experiment Station (WES) where bioassay tests utilizing the earthworm (*Eisenia foetida*) were conducted under controlled conditions ~~(ref. 4)~~.

Following the bioassay, the tissue and substrate samples were transported to MT-TNO Laboratories, for chemical analysis (ref. 5). A selection of samples was analyzed to establish generalized trends. All tissues were retained along with detailed collection information for future amplification of these studies.

## INTRODUCTION

The Morton Arboratum is a 615-hectare museum of living woody plants located about 35 kilometers west of Chicago, Illinois. This arboretum houses outdoor collections of woody plants from all north temperate climatic zones. About one-third of the grounds is occupied by woodlands that are remnants of a large oak grove in what was tall grass prairie in the presettlement period (1832). The remaining two-thirds is dominated now by Eurasian meadow grasses and forbs. The varying topograpy and wide array of native, clay/silt loam, circumneutral soils provide good opportunities for growing a variety of cultivated woody plants, of which the arboretum's collection currently contains 3500 different kinds.

Recent urban and suburban expansion has brought multi-lane motorways into close contact with the arboretum. Studies have documented the presence of airborne contamination from the motorway within the arboretum grounds, and phytotoxicity along gradients perpendicular to the motorway have been observed (ref. 1 and 2). Continuous contaminant intrusion threatens to alter soil chemistry lessens the arboretum's ability to maintain a diverse collection and limits its value as a background or reference area for contaminant mobility studies.

Elevated levels of heavy metals, particularly Pb and Cd have been reported from sampling stations near the motorway and a gradient of heavy metal contamination exists (ref. 3). In order to define further the gradient and assess the potential bioavailability of Pb and Cd, an earthworm bioassay was applied.

## RESULTS AND DISCUSSION

Because the transect begins at an elevation substantially higher than the road, it is assumed that motorway runoff is not a factor. Both substrate and animal tissue levels of Pb and Cd were higher in samples collected neart the motorway (Table 1). This is similar to the findings of Gish and Christensen (ref. 6). Additional analyses along the transect indicate that Pb and Cd levels are elevated as they enter the arboretum, but that the distribution of contaminants may not follow a simple gradient. The vagaries of wind direction and the internal road system of the arboretum itself may frustrate attempts to demonstrate a parabolic gradient.

The preliminary results shown in Table 1 indicate that Pb and Cd are concentrated in the sod and surface layers of the substrate. Earthworm tissue levels at 1 m depths show lowered concentrations of Pb and Cd. This suggests that contaminant concentrations are the results of longterm aerial depositions of materials originating along the motorway. Although the heavy metal levels decrease generally as the distance from the highway increases, the levels detected during preliminary studies appear to exist in concentrations that are unacceptable to lands designated for preservation such as the arboretum.

Table 1 Substrate and tissue levels of aerially dispersed lead (Pb) and cadmium (Cd) from samples collected along a 930 m transect from a motorway ; µg ash free dry weight.

| Distance from motorway (m) | | Pb | | Cd | |
|---|---|---|---|---|---|
| | | Substrate | Tissue | Substrate | Tissue |
| 31 | a | 214.0±42.9 | 14.0±2.4 | 37.4±10.7 | 47.4±5.8 |
| 33 | | 89.0 | 5.3 | 4.7 | 19.2 |
| 33 | SOD | 150.0 | 4.5 | 13.1 | 18.6 |
| 33 | 1-meter | 39.0 | 0.7 | 1.0 | 6.2 |
| 40 | | 70.0 | 2.1 | 2.3 | 9.3 |
| 60 | | 74.0 | 3.4 | 2.8 | 12.5 |
| 130 | | 91.0 | 4.7 | 9.7 | 18.6 |
| 350 | | 63.0 | 1.1 | 1.3 | 19.4 |
| 930 | | 43.0 | 5.0 | 1.0 | 7.0 |
| EARTH WORM TISSUE b | | | 0.75±0.2 | | 3.6±0.3 |

a Mean and standard deviation for four replications.
b Mean and standard deviation for two replications.

It is well known that heavy metal mobility in circumneutral soils is extremely slow, so that if the deposition rate exceeds the leaching rate, there is an inevitable build up of contaminants near the air/surface interface. Even in areas remote from the motorway, where only amounts of contaminants wwere deposited, an inexorable build up to an unacceptable concentration may occur. Future biomonitoring and laboratory studies will be designed to evaluate further these intrusions and determine preventative and remedial actions.

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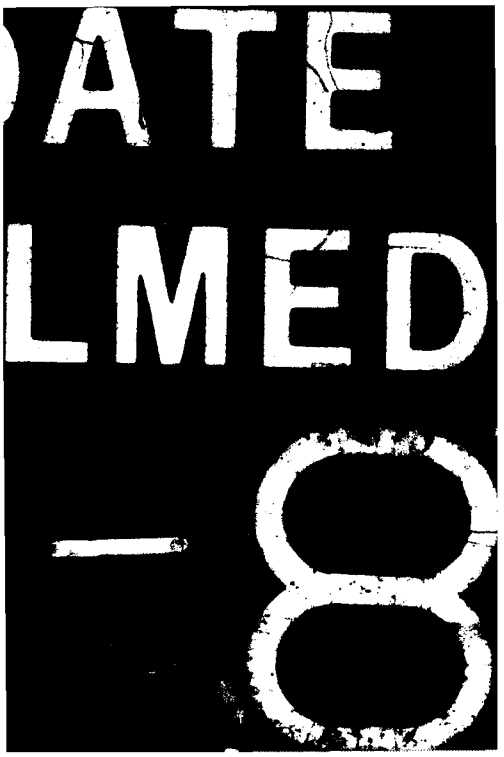
Appendices 1: R 87/023 Proceedings of the 1984 Workshop, held at Buffalo, USA

2: R 86/199 Musselwatching in the Buffalo River, Times Beach and Lake Erie

3: R 86/220 Preliminary inventory of planktonic and benthic organisms at Times Beach

4: P 85/50 Animal bioassays of black rock harbor sediments - Field verification at an experimental wetland-creation disposal site

5: P 87/007 Morton Arboretum Bioassays.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